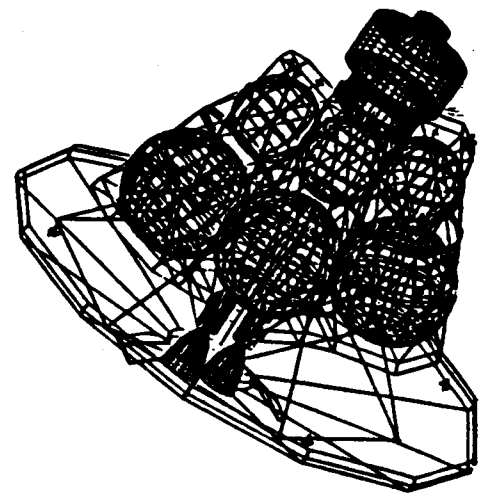
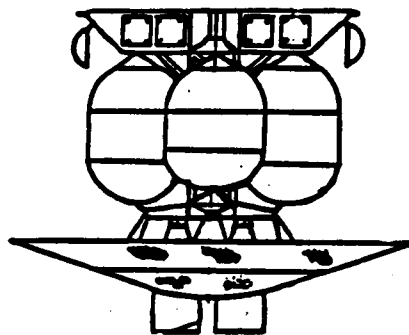
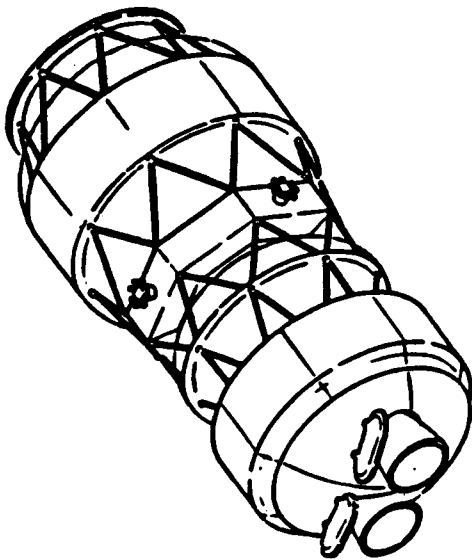


Boeing Aerospace Operations

ORBITAL TRANSFER VEHICLE Launch Operations Study



(NASA-CR-179701) ORBITAL TRANSFER VEHICLE
LAUNCH OPERATIONS STUDY. VOLUME 1: EXECUTIVE
SUMMARY Final Report (Boeing Aerospace Co.)
12 p

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EXECUTIVE SUMMARY VOLUME 1 OF 5

MARCH 7, 1986

FINAL REPORT

KENNEDY SPACE CENTER
NAS10-11165

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ABBREVIATIONS AND ACRONYMS

ACC	Aft Cargo Carrier
ASE	Airborne Support Equipment
ATKB	Automated Technology Knowledge Base
BAC	Boeing Aerospace Company
CCAFS	Cape Canaveral Air Force Station
CITE	Cargo Integration Test Equipment
CRYO	Cryogenic
DACC	Dedicated Aft Cargo Carrier
DIA	Diameter
ECS	Environmental Control Station
EPDC	Electrical Panel Distribution Control
EVA	Extra Vehicular Activity
FAC	Facility
GB	Ground Based
GBOTV	Ground Based Orbital Transfer Vehicle
GBPB	Ground Based Payload Bay
GDC	General Dynamics Convair
GEO	Geosynchronous Earth Orbit
GPS	Ground Power Supply
GPU	Ground Power Unit
GSE	Ground Support Equipment
H/B	High Bay
I/F	Interface
INSPEC	Information System in Physics, Electrical & Computer Control
IVA	Intravehicular Activity
KSC	Kennedy Space Center
LEO	Lower Earth Orbit
LPS	Launch Processing System
MCDS	Management Command Data System
MMC	Martin Marietta Corporation
MMSE	Multi Mission Support Equipment
MSFC	Marshall Space Flight Center

ABBREVIATIONS AND ACRONYMS (Continued)

NASA/RECON	NASA/Remote Console
NAV	Navigation
NTIS	National Technology Information System
N2	Nitrogen
O&M	Operations and Maintenance
OHC	Overhead Crane
OIS	Operational Intercommunications System
OMV	Orbital Manuevering Vehicle
OPS	Operations
ORU	Orbital Replaceable Unit
OTV	Orbital Transfer Vehicle
OTVCC	Orbital Transfer Vehicle Control Center
OTVCS	Orbital Transfer Vehicle Control Station
OTVPF	Orbital Transfer Vehicle Processing Facility
PCR	Payload Change-Out Room
PDI	Payload Data Interleaver
PGHM	Payload Ground Handling Mechanism
PI	Payload Interrogator
PLB	Payload Bay
POCC	Payload Operations Control Center
R&D	Research and Development
RCS	Reaction Control System
RF	Radio Frequency
RIS	Requirements Identification Sheet
RMS	Remote Manuevering Structure
RSS	Rotating Service Structure
SB	Space Based
SBOTV	Space Based Orbital Transfer Vehicle
SC	Spacecraft
STE	Special Test Equipment
TBD	To Be Determined
VAB	Vertical Assembly Building
VPF	Vertical Processing Facility
VPHD	Vertical Payload Handling Device
W/S	Workstand

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EXECUTIVE SUMMARY

The purpose of this study was to use the operational experience at the launch site to identify, describe and quantify the operational impacts of the various OTV configurations on the KSC and/or Space Station launch sites. OTV configurations are being developed/defined by the MSFC Phase A OTV Study contractor teams. Lacking an approved configuration, the KSC Study Team defined a "Reference Configuration" to be used for this study. This configuration then became the baseline for the identification of the facilities, GSE, personnel and crew skill's required for processing the OTV in a realistic manner that would help NASA achieve the lowest possible OTV life cycle costs.

This report is laid out in a fashion that divides the Primary Reports and supporting documentation into separate volumes as shown on page 6. The data was separated into individual packages to make it easier to accomplish other analyses as desired.

As the study progressed, our initial appraisal was re-enforced that the vehicle, when delivered, would be a sophisticated, state-of-the-art vehicle. It would be recovered and reused many times so the primary savings to be gained would be in the recurring-cycle of the vehicle operations -- even to the point where it would be beneficial to break from tradition and make a significant expenditure in the development of processing facilities at the beginning of the program. The study has provided a variety of flow-time and manpower (heads/skills) requirements, a technology identification system and several questions that need management attention concerning how business will be conducted in the OTV processing era. Early in the study it became apparent that a NASA management decision requiring "commonality" of equipments at the ORU level for Space Station, OMV and OTV programs would provide significant savings to the overall Space Program although it may be difficult to credit any one particular program element for accomplishments.

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11 PAGES

DETAILED SUMMARY

FINAL PRESENTATION
Appendix A

VOL 2

180 PAGES

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SUPPORTING DOCUMENTATION (VOL. 3, 4 & 5)

WORDS SHOWING RESULTS OF
RIS's
-- MP, TIME, FAC

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AUTOMATION TECHNOLOGY
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WORDS RELATING TO THE
MANPOWER AND
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CAPABILITIES

"BEST FIT" FACILITY
IDENTIFICATION REPORT

FACILITY MODIFICATION
REPORT

Appendix C

VOL 5

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A forward looking "Test Philosophy of the Future" was developed as a basic premise for this Study. This Test Philosophy was presented at KSC, MSFC and at NASA Headquarters early in the Study to be sure that there was general agreement with the approach being developed for use throughout the rest of the Study . This Test Philosophy withstood continual critiquing throughout the Study with no additional improvements offered.

```

graph LR
    R1[R & I 1] --> MECH3[MECH ASSY 3]
    R1 --> MECH2[ELECT ASSY 2]
    MECH3 --> MECH4[MECH TESTS 4]
    MECH2 --> MECH4
    MECH4 --> ELECT5[ELECT TESTS 5]
    ELECT5 --> a((a))
    
    a --> INTEG6[INTEG. 6]
    INTEG6 --> OTV7[OTV/CS 7]
    OTV7 --> MOVE_OTV[MOVE OTV]
    MOVE_OTV --> CRYO9[CRYO LD/ DN 9]
    CRYO9 --> b((b))
    
    subgraph CONCERN [CONCERN-- NO EXT VEH ENVIR CONTRL]
        MOVE_OTV
        CRYO9
    end
    
    b --> MOVE10[MOVE OTV 10]
    MOVE10 --> MATE11[OTV/SC MECH/ELEC MATE 11]
    MATE11 --> INTEG12[INTEG 12]
    INTEG12 --> c((c))
    
    R1 --- A1((A))
    A1 --- OPTION1[OPTION]
    INTEG6 --- A2((A))
    A2 --- OPTION2[OPTION]
    OTV7 --- B1((B))
    B1 --- OPTION3[OPTION]
    MOVE10 --- B2((B))
    B2 --- OPTION4[OPTION]
  
```

7

and refurbishment activities were required to prepare the OTV for return to a flow for its next mission. The above sample flow was then expanded to encompass the total flow as generally outlined above.

A second iteration continued the flow development to a greater level of detail to identify subtasks for each of the individual tasks so that requirements for facilities, time, equipment and people could start to be determined.

As soon as these were complete, another, similar flow was started for the Space Based operations that used the same major block numbers so that similar tasks could be directly correlated with a minimum of confusion. Flows for both Ground Based and Space Based OTV's are included in this report (see Vol. 3).

The various requirements for each set of flows were identified on a standardized format used later for the various types of manual and automated analyses to be conducted. We identified these sheets as Requirements Identification Sheets (RIS's) of two different types for the two launch sites -- the Space Based OTV (SBOTV) and the Ground Based OTV (GBOTV) RIS. The difference being caused by the difference in the types of personnel, facilities and equipment involved in the particular operation being considered.

There is a three page GBOTV RIS for each of the vehicle's individual ground processing flow sub-tasks. The GBOTV RIS's contain a separate requirement identification for each of 35 facility items, numbers of people and types of skills, processing times and any special equipment required to accomplish the designated task.

DETAILED RESOURCES IDENTIFICATION TASK NO. 6 INTEGRATED SYSTEM TEST (GSE & STE)		
DETAILED RESOURCES IDENTIFICATION TASK NO. 6 INTEGRATED SYSTEM TEST (FACILITY REQUIREMENTS)		
DETAILED RESOURCES IDENTIFICATION TASK NO. 6 INTEGRATED SYSTEM TEST (CREW SIZE/SKILLS)		
SUBTASK NO. (6 0400) DESCRIPTION (INTEGRATED SYSTEMS OPERATION)		
Hazard Level: None		
Activity: Configure GPS/ GSE and transmission systems transmit command (K-BAND CLR)		
Personnel	Vehicle	Remote Control Station
Payload Specialist(s)	(0)	(0)
Engineering	(2)	(3)
Shop	(3)	(3)
Inspector	(1)	(2)
Other	(0)	
Sub Total-----		(6)----- (8)
Serial Time To Complete 1438 min		Total Manhours (335.5)
Automation Need (Primary Key) <u>ATE / GPS / GSE</u>		
Automation Secondary Key(s) <u>REMOTE CONTROL</u>		

The SBOTV RIS's for each of the vehicle processing flow sub-tasks are similar to the Ground set in that they identify the requirements for processing support capability that must be provided for each sub-task. In this case; however, the RIS is a four page set of requirements for the support that must be available at the Space Station for processing the Space Based OTV.

A methodology was developed to provide the designer easy access to the latest automation technology. Several data bases were reviewed but the same general problem was evident in all -- the data was generally there but relatively inaccessible without an extensive investment of research time to find information that was pertinent to the problem one was trying to resolve. This "production slowdown" was resolved by developing the Automation Technology Knowledge Base (ATKB) having to do with the latest, documented automation technology (we limited the information in the ATKB to that developed since 1982). The ATKB Thesaurus was compiled and is available for use with the NASA RECON system to identify technology developments applicable to OTV system processing. Using the ATKB, see Vol. 4, allows one to quickly determine if there is any documentation available pertaining to a specific subject without having to manually review several hundred papers to find the right ones (or to determine if any exist at all!).

The resident capabilities of selected KSC facilities were digitized and used in the requirements analysis of the capability of 1985/1986 era KSC facilities to satisfy the OTV Processing Facility (OTVPF) needs. Facility scheduling was not a part of that data base nor a part of that analysis because Program schedules for the 1994 era were not available. Availability of the VPF and the CHSF was questionable (so they were included here) but the O & C High Bay was definitely ruled out because it was already committed to the Space Lab and Space Station

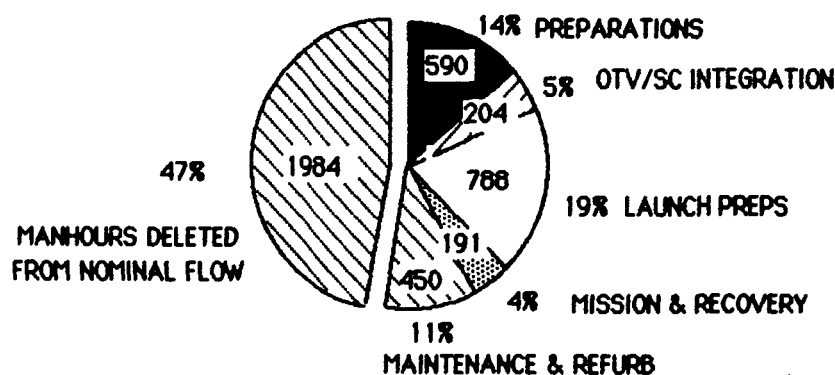
Programs (so the O & C facility was excluded from the analysis).

Seven KSC facilities; the CHSF, the VPF, SAEF 2, and Hangars S, AE, AO, and AM were selected as potential candidates for the OTV processing. The engineering tool developed to accomplish this analysis compares each of the 35 overall facility requirements consolidated from any selected, sequential group of the 138 separately identifiable processing sub-tasks for the GBOTV, for example, to the 35 "baseline" facility capabilities for each of the seven identified KSC facilities in the sorting/comparison/analysis process. The 35 line items can be individually "weighted" to highlight a particular item that may be more critical to an operation or more significant than the others. This will affect the "scoring system". Each facility is given a "relative score" to show how it compares in general to the others being considered; the score has no significance other than to determine which facility scores the highest. The facility with the highest score is judged to be the best because it will need the fewest modifications. That facility is identified, and the modifications required to make that facility provide all the support levied in the composite RIS is documented. If two facilities end up with the same relative score, the system will select the first one that it "sees".

The skills, manpower, serial task time and total manhours to accomplish each of the subtasks in the ground based, or space based, flow were accumulated in a spreadsheet format so that any change would be immediately reflected in the overall totals. Developing the data in this manner allows a variety of displays of the data in several different formats -- each useful in its own way for different presentations, discussions or decision making meetings. The raw data is included in Vol. 5 of this report so that one can develop their own analyses pertinent to their specific needs.

A typical, summary chart showing the amount of manpower **not** required on the recurring flow is shown (as a separated element of a pie chart) below. The manpower savings shown can be realized if the developed test philosophy is followed, the flight and ground hardware provided meets the reliability and commonality objectives and test operational practices suggested are followed.

GND BASED OTV MANHOURS RECURRING FLOW
PERCENT OF FIRST NOMINAL FLOW



Several different types of comparative sets of information and formats that could be used for display purposes are shown in the material contained in Manpower Section (Sect. 7) of the Final Presentation material (see Appendix A, Vol. 2). Additional formats are available, or could be developed, for other types of presentations, if required.